



# Tutorial 2: HomePlug information and pairing tutorial

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## 2.1 HomePlug introduction

### 2.1.1 What is HomePlug, and how does eGauge use this?

HomePlug is a specification of Power Line Communications used to transmit networking data over existing power lines. It is commonly used to create a network bridge over a home or building where Wi-Fi can not work or is not convenient. A HomePlug adapter can be connected to a router with Internet access, and another can be placed elsewhere in the building so network devices may connect to it.



**Figure 2.1:** Actiontec HomePlug 1.0  
(eGauge2)



**Figure 2.2:** Actiontec HomePlug AV  
(EG301x)

The eGauge main unit contains a HomePlug chipset and will transmit data over the existing power lines to a HomePlug adapter and into the network to enable Internet access.

### 2.1.2 Technical and environmental considerations

#### Phasing

HomePlug communication travels along the phase connected to L1 of the eGauge. The HomePlug adapter must be plugged into an outlet on the same phase as L1.

#### Signal Deterioration and Loss

HomePlug signals can be filtered out by surge suppressors and noise filters, and will deteriorate as the length of wire between the eGauge unit and HomePlug outlet increases. Factors such as load and noise generated by other devices will affect the maximum distance communicable. Typically, between 50 and 100 feet of wire is suitable for the devices to communicate without disruption.

If the power lines that supply the building are protected with a TVSS system in the breaker panel, the HomePlug signal will quickly be dissolved when the devices try to communicate across circuits. A work around for this situation would be to put the HomePlug adapter's outlet on the same breaker as the eGauge.

If distance and noise become an issue for the signal, an outlet can be added closer to the panel where eGauge is located (again, the outlet needs to be on L1 relative to the eGauge inputs).



**Figure 2.3:** *How the eGauge connects*

### **Voltage Limitations<sup>1</sup>**

The Actiontec HomePlug adapters sold by eGauge Systems LLC are rated for voltages up to 240Vac (50 or 60Hz). Sites operating at higher voltages require a small transformer to step down the voltage to a range suitable for the HomePlug adapter. The transformer must be small enough so as not to filter out the HomePlug signal.

For 3-phase/277V (480V-phase-to-phase) installations, eGauge Systems LLC stocks a transformer kit, which will step down 277Vac down to 120Vac, suitable for powering the HomePlug adapter. The transformer is rated for 25VA of power, suitable for powering another one or two auxiliary devices, provided total power consumed does not exceed 25VA.

Please see <http://www.egauge.net/docs/277v-hpt-manual.pdf> for more information on the transformer kit.

### **Multiple HomePlugs on a Network**

A single power line location can support up to 16 HomePlug devices, so you can have many eGauges communicated via a single HomePlug Ethernet adapter. Communication may be affected above that limit.

Issues arise if there are multiple HomePlug Ethernet adapters connected to the same network. For example, if eGauge01 and HomePlug01 are connected to the same network as eGauge02 and HomePlug02, a routing loop will occur and is very likely to cause the network to crash.

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<sup>1</sup>The eGauge model EG30xx has built-in Ethernet and may be used to circumvent the need for a HomePlug adapter.

The solution is to provide eGauge01 and HomePlug01 a separate HomePlug encryption key, such as Key01, while eGauge02 and HomePlug02 are on another, such as Key02.

See [2.2 Changing the HomePlug encryption key](#) to change HomePlug device's security keys.

### 2.1.3 How secure is HomePlug communication?

**EG301x** models uses the HomePlug Green PHY specification and is compatible with HomePlug AV using 128-bit AES encryption. The EG301x and HomePlug AV adapter may be paired using push buttons located on the devices.

**eGauge2** models uses a HomePlug 1.0 link to transmit data to the installation site's LAN. The data on this link is encrypted with 56-bit Data Encryption Standard (DES).

By virtue of the technical limitations described previously, the reach of the HomePlug signal is usually constrained to a single building. More specifically, most transformers will stop the HomePlug signal. For this reason, there is little risk of a third party intercepting the communication. Furthermore, due to the nature of how HomePlug works, even if the HomePlug signal were detectable, it would be exceptionally difficult for a third-party device to interpret the point-to-point traffic between two other devices. Therefore, for most owners of HomePlug devices, privacy of communication is assured without any further steps.

Even if a neighbor could pick up the HomePlug signal, any traffic other than broadcast traffic is difficult to snoop on because the transmission-characteristics of power-lines is so poor that, in practice, communication between any pair of devices cannot be picked up by a third device. In other words, the worst that could happen in such a scenario is that the neighbor could pick up some broadcast traffic or could use your Internet connection for their own purposes.

For extra security and when using HomePlug devices in an apartment or condo, where multiple residences may be powered by a single transformer, it is possible to increase security by establishing a new encryption key to be used for HomePlug traffic. By default, HomePlug 1.0 devices, for use with the eGauge2 are configured to encrypt communication using the default password "HomePlug". HomePlug AV, for use with the EG301x models, have a default encryption password "HomePlugAV". The HomePlug page under Settings on eGauge can be used to change the default password to a secret password. See [2.2 Changing the HomePlug encryption key](#) on how to change your HomePlug device's passwords.

## 2.2 Changing the HomePlug encryption key

### 2.2.1 Push-button timing for EG301x and Actiontec HomePlug AV PWR-500

#### EG301x push-button timing

Push Duration:	Status LED:	Description:
0.5 – 3 sec	rapidly blinks blue & black	<b>Join mode:</b> device will attempt to join an existing HomePlug AV network.
13 – 16 sec	rapidly blinks red & blue	<b>Leave mode:</b> device randomizes its HomePlug AV encryption key, thus leaving any networks it may have been a member of.
20 – 30 sec	rapidly blinks red & green	<b>Factory reset:</b> device restores itself to factory defaults.

**Table 2.1:** *EG301x push-button times*

#### Actiontec PWR-500 HomePlug AV push-button timing

Push Duration:	LEDs:	Description:
0.5 – 3 sec	All LEDs blink on and off	<b>Join mode:</b> device will attempt to join an existing HomePlug AV network.
5 – 10 sec	All LEDs turn off and on. LK LED should remain off	<b>Leave mode:</b> device randomizes its HomePlug AV encryption key, thus leaving any networks it may have been a member of.
14 sec	All LEDs turn off and on	<b>Factory reset:</b> device restores itself to factory defaults.

**Table 2.2:** *Actiontec HomePlug AV PWR-500 push-button times*

### 2.2.2 Push-button pairing on EG301x and Actiontec PWR-500

eGauge model EG301x can be paired with the Actiontec PWR-500 using the push buttons located next to the Ethernet port on the eGauge, and the underside of the Actiontec adapter. The eGauge's push button is internal, so a standard 0.8mm paper clip can be used to activate the push-button located directly behind the hole. **Table 2.1** contains the different push-button actions and timing for the EG301x, and **table 2.2** contains the different push-button actions and timing for the Actiontec PWR-500 HomePlug AV adapter.

1. To begin, verify the Actiontec PWR-500 and EG301x are powered and within communication range of each other. The HomePlug adapter does not need to be connected to the internet during this phase.
2. Hold the EG301x reset button for **13 – 16 seconds**. The eGauge LED will rapidly blink **red and blue**. Let go of the reset pin at this point. The eGauge will be dissociated with any HomePlug networks, and the LED will alternate between blue and cyan (or solid blue if a static IP is assigned).
3. Hold the Actiontec PWR-500 reset button for **5 – 10 seconds**. All LEDs will turn off momentarily. The LNK LED will not be illuminated after this, as the key will be randomized and dissociated with any HomePlug network communication.
4. Hold the eGauge reset pin for **0.5 – 3 seconds**. The status LED will begin to rapidly blink blue and black. The eGauge is now in join mode.
5. Hold the Actiontec PWR-50 reset button for **0.5 – 3 seconds**. The PWR LED will alternate on and off until it is paired or it times out.

The devices will pair. This can take 5 – 120 seconds depending on the signal strength. The eGauge status LED will show green, indicating a good HomePlug link. The LK LED on the HomePlug will also illuminate, indicating a HomePlug link.



**Figure 2.4:** Actiontec PWR-500 reset button



**Figure 2.5:** EG301x reset pin



### 2.2.3 Pairing the eGauge2 or EG301x HomePlug communications through the web interface

#### Required information

To change the HomePlug encryption key you must know the Device-ID and MAC address for each device (HomePlug and/or eGauge) you wish to put on the same HomePlug network. The MAC address printed on the back of the eGauge will differ by the last bit when viewed from HomePlug settings, as the HomePlug and Ethernet protocols have different MAC addresses.

The Device-ID is a unique 16 character long string unique to each HomePlug device in the format XXXX-XXXX-XXXX-XXXX where X is an uppercase letter. Different manufacturers may identify this value by a different name; Netgear adapters say PWD, IOGear DEK, and Actiontec Device ID or DEK. The MAC address is a 12 character hexadecimal (valid characters are 0 to 9 and A to F) string unique to every network device. It may be in the format XX:XX:XX:XX:XX:XX, or just XXXXXXXXXXXX (Where X is 0 to 9, or A to F). **Be sure to match Device-IDs to their corresponding MAC addresses in the following section.**

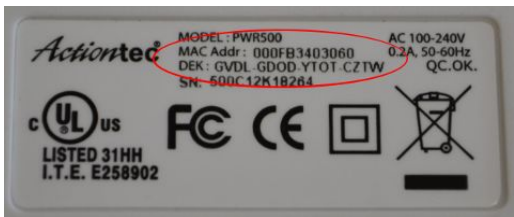


Figure 2.6: Actiontec PWR-500 MAC and DEK (EG301x)

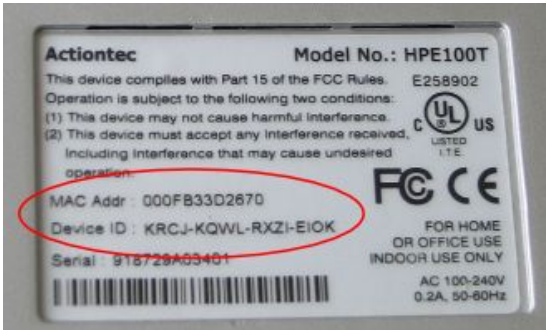


Figure 2.7: Actiontec HPE100T MAC and DEK (eGauge2)

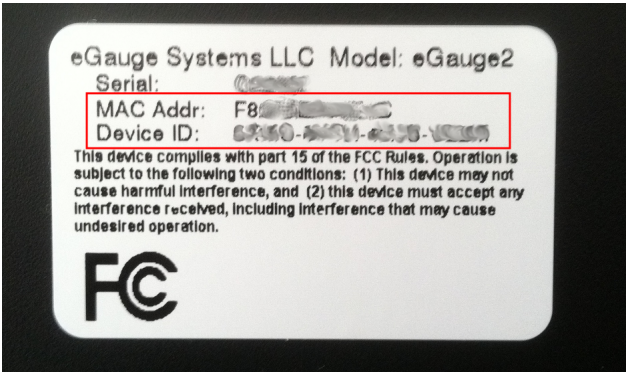


Figure 2.8: Reverse side of an eGauge, MAC and DEK

Note that the HomePlug adapter will likely have to be unplugged to view this information, and the eGauge may need to be turned off or removed from the panel if mounted. The MAC address for the eGauge is also available on the installation sheet that shipped with the device, and under **View** → **Device Status** on the eGauge when logged in.

## Interface configuration steps



**The HomePlug password will be changed for the eGauge you are configuring it from, as well as any devices you enter the Device-IDs to.**

**You will NOT see the eGauge currently being used listed on the page!**  
**Once you change the password on the devices, they will no longer be able to communicate to devices that do not have the same password or encryption key!**



1. Connect to your eGauge.
2. Open the Settings page by clicking the **Settings** link above the upper right corner of the eGauge page.
3. Click on **HomePlug** on the left hand navigation bar.
4. Find the correct MAC address on the listing with the one obtained from the device you wish to pair with the eGauge.
5. Enter the **Device-ID** (Or DEK, PWD, etc) to that device.
6. Repeat this step for any additional eGauges you are pairing with this encryption key.
7. Choose a password for the HomePlug network.
8. Click **Save**. If the Device-ID was entered incorrectly, you will get an error and the password will not save.



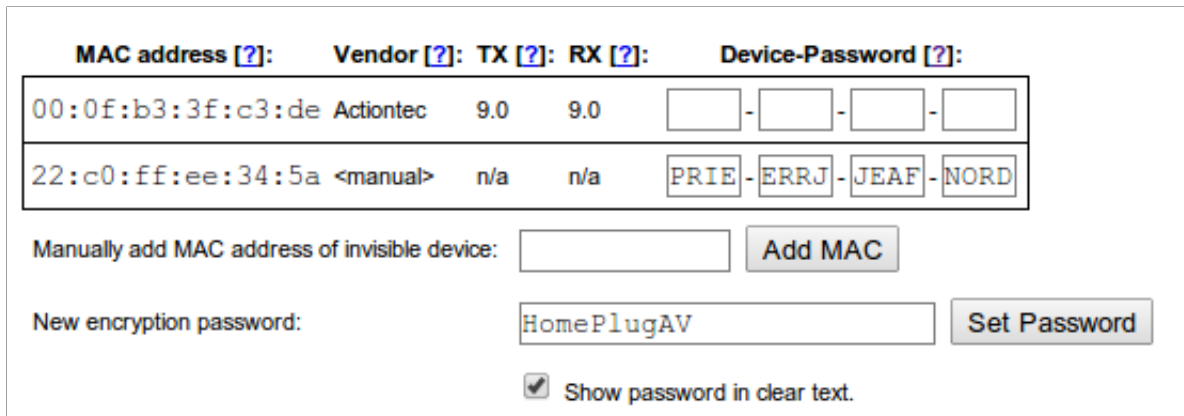
### 2.3 Recovery of HomePlug devices

In the event the HomePlug password does not get established on all devices correct, communication with the eGauge may be lost.

There are two ways of rescuing an "orphaned" device.

#### Recovery of HomePlug device via eGauge HomePlug interface

The HomePlug configuration screen on the eGauge has an option for adding the MAC address of an "invisible" device. Here you can enter the MAC address address of an eGauge or a HomePlug that has a unique encryption key with no way to communicate.



MAC address [?]:	Vendor [?]:	TX [?]:	RX [?]:	Device-Password [?]:
00:0f:b3:3f:c3:de	Actiontec	9.0	9.0	- - - -
22:c0:ff:ee:34:5a	<manual>	n/a	n/a	PRIE-ERRJ-JEAF-NORD

Manually add MAC address of invisible device:

New encryption password:

☒ Show password in clear text.

Figure 2.9: Rescuing an orphaned device

The above situation could be used to reset the encryption key on a HomePlug AV device that has MAC address 22:C0:FF:EE:34:5A and restore communication.

#### Recovery of HomePlug device via computer software

This utility works on Windows computers only. There are other available HomePlug programs but only the Actiontec and Netgear (available at <http://egauge.net/docs/egauge-security-whitepaper.pdf> under HomePlug Security) utilities have been verified by eGauge. It is strongly advised you complete all HomePlug pairing via the eGauge interface as these software utilities may operate less clearly or allow you to modify other HomePlug devices unintentionally.

Netgear HomePlug 85Mbps configuration utility:

[http://kb.netgear.com/app/answers/detail/a\\_id/901](http://kb.netgear.com/app/answers/detail/a_id/901)

Actiontec HomePlug configuration utility (hosted on eGauge.net):

[https://www.egauge.net/support/HPE100T\\_Utility.exe](https://www.egauge.net/support/HPE100T_Utility.exe)

## 2.4 Example HomePlug network setups

adapter through which eGauge connects to the LAN. Otherwise, it will **not be possible** to connect to eGau

MAC address [?]:	Vendor [?]:	TX [?]:	RX [?]:	Device-Password [?]:
00:0f:b3:3f:	Actiontec	9.0	9.0	ABCD-EFGH-IJKL-MNOP

Manually add MAC address of invisible device:

New encryption password:

☒ Show password in clear text.

Figure 2.10: A single eGauge unit with a HomePlug

If another HomePlug device is added to the network, the “SecurePassword!” network will be unable to communicate with these new devices (unless those devices’ passwords are set to “SecurePassword!”).

MAC address [?]:	Vendor [?]:	TX [?]:	RX [?]:	Device-Password [?]:
f8:2f:5b:00:	eGauge	9.0	9.0	ABCD-FNOR-DJKL-MNOP
00:0f:b3:3f:da:e5	Actiontec	9.0	9.0	LORE-MIPS-UMDO-LORS

Manually add MAC address of invisible device:

New encryption password:

☒ Show password in clear text.

Figure 2.11: Setting a password on multiple eGauges connected to the same HomePlug

If another HomePlug adapter or eGauge is powered on in range, by default it will **not** be able to communicate with this group after the password is set.

MAC address [?]:	Vendor [?]:	TX [?]:	RX [?]:	Device-Password [?]:
f8:2f:5b:00:	eGauge	9.0	9.0	<input type="text"/> - <input type="text"/> - <input type="text"/> - <input type="text"/>
00:0f:b3:3f:da:e5	Actiontec	9.0	9.0	ABCD - EFGH - IJKL - MNOP
00:0f:b3:3f:da:25	Actiontec	9.0	9.0	<input type="text"/> - <input type="text"/> - <input type="text"/> - <input type="text"/>

Manually add MAC address of invisible device:

Add MAC

New encryption password:

EastPanelKey

Set Password

Figure 2.12: Setting a separate password for an eGauge and HomePlug adapter pair

If the remote eGauge with MAC *F8:2F:5B...* is communicating with the HomePlug adapter ending with *DA:25* in one location and the current eGauge is communicating with HomePlug adapter ending in *DA:E5* in another location on the **same network** They **must** have different encryption keys or it can cause a networking loop disrupting all communication on the network.

Note that after configuring the current eGauge to only communicate with HomePlug ending in *DA:E5*, it will NO LONGER SEE the other eGauge (*F8:2F:5B...*) and Actiontec adapter (ending in *DA:25*), as they will be on a different HomePlug network. At this point, changing the password for those devices must be done from the web interface of eGauge *F8:2F:5B...*